Report for 2003WY11B: Subsurface Drip Irrigation Systems: Assessment and Development of Best Management Practices

- Articles in Refereed Scientific Journals:
  - Hao, X., R. Zhang, and A. Kravchenko. 2005. Effects of Root Density Distribution Models on Root Water Uptake and Water Flow under Irrigation. Soil Science,170:167-174.
- Conference Proceedings:
  - Hao, X. and R. Zhang. 2004. A hybrid mass-conservative scheme for simulating variably saturated flow in soils with large outflow flux. Proceedings of Computational Methods in Water Resources 2004 Conference. UNC-Chapel Hill, North Carolina.

Report Follows

Abstract:

Development of best management practices (BMP) for irrigated agriculture has become essential because efficient use of water is crucial with the ongoing drought in Wyoming and because irrigated agriculture contributes to nonpoint source pollution of our ground and surface waters. Proper management of water and the appropriate application of fertilizers can increase agricultural productivity while minimizing water quality degradation. Microirrigation, such as subsurface drip irrigation (SDI), offers the opportunity for precise application of water and fertilizers. Such irrigation methods are being developed as environmentally-friendly farming practices and systems. In the proposed study, field experiments and computer modeling will be conducted to quantify both water and fertilizers uptake by crops, and the potential of nitrate leaching into ground water in subsurface drip and flood irrigated fields. Detailed field data and comprehensive numerical simulations will help us to understand many theoretical and technical questions in the applications of SDI. The study will provide the necessary information for developing and/or improving irrigation management to enhance crop (e.g. alfalfa) productivity and to minimize ground and surface water contamination.

Current Project Status:

The research site is at the University of Wyoming's College of Agriculture Research and Extension Center located in Albany County. Use of this research site has proven to be beneficial to the study. Its location is convenient for frequent site visits and extension personnel are able to assist us with site preparation and operation. All necessary drip irrigation equipment was installed in the spring and summer of 2004. Installation was a time consuming process as drip irrigation tape pulling (shanking) equipment could not be used because it is difficult to ensure proper drip line burial depth with this type of installation. All drip lines were trenched to proper depth. Shown in Figure 1 is the subsurface drip irrigation (SDI) system design and dimensions of the field site. Nine SDI zones were installed with variable burial depth and spacing. Irrigation tape was place at burial depths 30 cm, 50 cm and 70cm. The shallowest depth is being used in this study to see if soil surface saturation and seed germination are possible when only using SDI technology. Deeper installation depths are more representative of a typical application and may provide greater water use efficiencies. However, the deeper design must be augmented with some surface irrigation to achieve seed germination. Shown in Figure 2 are the valves and computer controls for the research site and also open trenches where dip lines were installed. Due to installation delays, the site was not ready for seeding until the end of the summer and shown in Figure 3 is the site being planted with alfalfa for the 2005 growing season. The site is operational and field measurements will begin in 2005. In addition to field equipment installation, permeability spatial variability measurements were made at the site this last year with results shown in Figure 4. These measurements will be used when modeling water distributions and when relating system design to site productivity values. We have carried out some initial modeling related to subsurface irrigation. These numerical experiments were conducted to study the special boundary conditions charactering the dripper and soil relationship. We also have improved the irrigation simulation model for a better mass balance. (Hao and Zhang, 2004, 2005).

The project study site is ready for applications of both surface and subsurface irrigation starting in the spring. Based on information obtained during next year's growing season, we expect that our results will be useful in understanding the relationship between SDI row spacing and emitter distance on the SDI tape to that of alfalfa production, water use, and potential SDI applications in Wyoming. As an added benefit, we envision our results will be useful as a comparison to current agricultural practices that have low water use efficiencies. Data obtained from next year's field, laboratory and modeling efforts will be used for a future grant application (*e.g.*, USDA, WSARE, Department of Agriculture, etc.) to enhance and continue our SDI research for Alfalfa production in Wyoming.

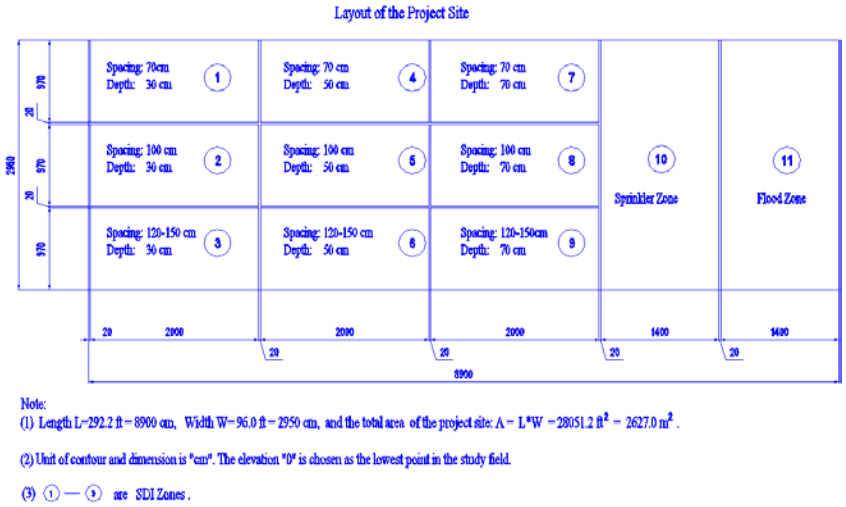

Figure 1 – Research site dimensions and SDI design.

Figure 2 – Computer and valve controls for the SDI research site and open trenches for SDI lines.

Figure 3 - Seeding the site with alfalfa.

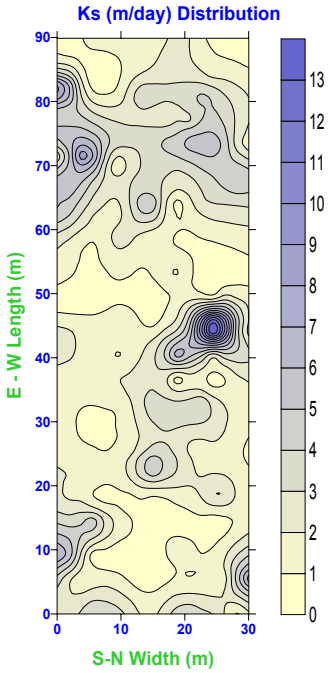

Figure 4–Spatial variability of permeability at the research site.

Student Training:

Two graduate students were supported with project funding this past year. One student was responsible for experimental design and equipment installation and both students assisted with site permeability measurements and modeling work. These students are receiving training related to water resources engineering through academic course work, research project activities and opportunities to interact with irrigators. Three undergraduate students assisted with site permeability measurements and irrigation equipment installation.

Youquan Jiang, PhD, Civil Engineering, University of Wyoming
Xinmei Hao, PhD, Renewable Resources, University of Wyoming
Christopher York, BS Civil Engineering, University of Wyoming
Diogo Lousa, BS Civil Engineering, University of Wyoming
Dan McGillvary, BS Civil Engineering, University of Wyoming

Meetings/Presentations/Publications:

Hao, X. and R. Zhang. 2004. A hybrid mass-conservative scheme for simulating variably saturated flow in soils with large outflow flux. Proceedings of *Computational Methods in Water Resources 2004 Conference*. UNC-Chapel Hill, North Carolina.

Hao, X., R. Zhang, and A. Kravchenko. 2005. Effects of Root Density Distribution Models on Root Water Uptake and Water Flow under Irrigation. *Soil Science*,170:167-174.

Hao, X., and R. Zhang, 2005. A Mass-Conservative Switching Method for Simulating Water Flow in Saturated-Unsaturated Soils. J. Hydrology (in press).